

range is only $1\frac{1}{2}$ inches at Duluth and one-third inch at Marquette.

In Appendix No. 7 is given a detailed description, with appropriate illustrations, of the long wire drag, a device for detecting erratic obstructions of small extent in navigable waters. The method of operating can be understood from the simple statement that the drag is a wire varying in length from 480 feet to 1400 feet, supported at suitable intervals, and maintained at any desired depth below the surface of the water. This drag is towed over any given area by launches, and in the area so searched no elevation of the bottom above the depth at which the wire is suspended can escape detection. Buoys floating at regular intervals along the drag indicate to observers in the launches when and where an obstruction is touched, and the spot so indicated is then accurately determined.

This method of sweeping has proved a sure means of detecting pinnacle rocks and similar erratic obstructions which heretofore have eluded the hydrographic surveyor, since it is almost impossible to discover them by lines of soundings with the lead. Only the navigator in whose hands rest many lives and much property can realise the relief from mental strain that comes from knowing that the water in which he is sailing is absolutely free from hidden dangers, or that every menace is charted. The device has proved very satisfactory under widely varying conditions, and marks a decided advance in marine surveying.

The report, or any one of the appendices, may be obtained by interested persons, free of charge, upon application to the superintendent of the Coast and Geodetic Survey, Washington, D.C., U.S.A.

THE MECHANICS OF THE INNER EAR.

THE University of Missouri has recently issued a memoir by Prof. Max Meyer, in which an interesting, instructive, and suggestive attempt is made to explain the mechanism of the cochlea without having recourse to the application of the principle of sympathetic vibration, or rather without the assumption that there exists in the cochlea, in the form of the organ of Corti, a vast number of delicate structures tuned, as it were, to tones of different frequencies. Prof. Max Meyer does not base his views on experimental data; his paper is a purely theoretical discussion as to how the cochlea may act, if we make six fundamental assumptions, none of which can, at present at all events, be tested by direct examination or by direct experiment. His inquiry begins with the movements, in and out, of the stapes at the oval window. The tube filled with fluid is divided into three compartments, the upper, the scala vestibuli, communicating at the apex of the cochlea with the scala tympani, at the foot of which we find the round window, while between the two scalæ we have the cochlear duct, or scala intermedia, composed, in its turn, on one side by the basilar membrane, on which rests the organ of Corti, and on the other by Reissner's membrane. When the base of the stapes is pushed inwards at the base of the scala vestibuli, pressure is communicated to the fluid in the scalæ (the scalæ communicating at the apex of the cochlea by a little opening, the helicotrema), and the membrane of the round window passes outwards, towards the tympanic cavity. It is generally held that with such pressure the fluid in the scalæ moves as a whole, and that pressure is communicated to the whole length of the scala intermedia, and especially to the basilar membrane, and that in this way the nerve-endings in Corti's organ are also submitted to pressure. The question then arises, is there any differentiating mechanism in the basilar membrane or in Corti's organ for tones of different frequencies, or, in other words, have we here an organ capable of analysis? Some deny any such property, while others, since the views of Helmholtz were first promulgated, are of opinion that there does exist an analysing mechanism.

The theory of Prof. Meyer essentially is that when the base of the stapes is pressed inwards a section of the

membrana basilaris is also pressed in one direction until it reaches its limit of movement. On the basilar membrane rests the organ of Corti, the delicate hair cells being supported on the backs of the rods or arches of Corti. The membrane of Reissner may be regarded as merely protective, and a similar function Prof. Meyer awards to the arches of Corti, which are a kind of skeleton to prevent the delicate hair cells and nerve endings from being crushed by downward pressure on the membrana basilaris. No one can say what is the function of the membrana tectoria, the cushion-like structure that lies over the apices of the hair cells, and the nerve endings that, according to some histologists, lie between the hair cells. It may be a damper or it may be the arrangement by which pressures are made on the apices of the hair cells or nerve endings. There is thus, according to Prof. Meyer, a movement in one direction of a segment of the membrana basilaris, the direction being towards the scala tympani. When the base of the stapes has passed inwards to its fullest extent, the segment also moves to its limit, and then when the base of the stapes passes outwards the segment passes in the reverse direction, that is, towards the scala vestibuli. The rest of the basilar membrane beyond the segment is undisturbed. It is not known whether the basilar membrane is elastic or not; most probably it is non-elastic, but its backward swing has also its limits, and the velocity of the backward spring is probably slower than its forward swing, seeing that it is weighted on one side by the Corti cells, &c. The intensity of the tone will be determined by the amplitude of movement of the base of the stapes—the extent of the segment being greater as the amplitude is greater, and the reverse. Assuming that the number of nerve fibres in each segment is the same (which is unlikely), the greater the extent of the segment the greater will be the number of nerve fibres irritated, and the greater will be the intensity. The pitch will, of course, depend on the frequency of the movement of the segment, and there is no necessity for the assumption that either segments of the membrana basilaris, or structures upon these, are tuned to certain frequencies. When a compound tone or sound, say a fifth (the frequencies of the components of which are in the ratio of 3:2), is sounded, the base of the stapes makes a more complicated movement than that of a simple pendular vibration, and then this compound movement is resolved by two segments of the basilar membrane moving synchronously, in the ratio of 3:2, and the nerve endings in one segment would be irritated thrice during the time that the nerve endings in the other segment would be irritated twice. Still more, a segment at or near the base of the stapes would move once in the same time, and give rise to the differential tone, and so on.

Prof. Meyer thus recognises the cochlea as an analytic apparatus, without the necessity of any tuned mechanisms, and he works out his theory with great clearness, much ingenuity, and perfect fairness. His explanations of differential tones are in perfect consistence with his theory, and they are graphically delineated. He does not pretend that his theory is an ultimate solution of the problem attacked. Data are still wanting to found a final theory, and when we consider the minute size of the parts involved, it will probably be many a day before these data have been collected. But as experimental, and even observational, research must start from theory, however imperfect, Prof. Meyer has done good service in advancing his views.

The writer would only remark that he finds it easier to conceive the existence in the cochlea of arrangements adapted to frequencies, and consequently of an analysis by resonance, than to think of the membrana basilaris, short as it is, moving in segments when a complex mass of tones is objectively produced. Such a cochlea as Prof. Meyer has conceived might work in the way he thinks, and the writer would suggest that he should make a huge model, with a big piston, and ascertain whether a stout leather non-elastic membrana behaves as he expects it to do. The writer thinks that Helmholtz's resonance theory, with slight modifications, still holds the field, nor does it seem to him to be negatived (and the same remark applies to the theory of Prof. Meyer) even by the difficulties created by a consideration of differences of phase. The physiological effect produced by the relative intensity of a com-

¹ "An Introduction to the Mechanics of the Inner Ear." By Prof. Max Meyer. Science Series of the University of Missouri Studies. Pp. 140. (1907.) Price 1 dollar.

ponent of wave forms produced by components combined in different phases may enable us to distinguish one wave form from another, although, as has been proved experimentally, the forms must be different.

JOHN G. MCKENDRICK.

COLOUR PHOTOGRAPHY.

THE second annual exhibition of the Society of Colour Photographers will be open at 24 Wellington Street, Strand, until June 27. It includes about 230 examples prepared by the various methods that are now available. The section of transparencies on Lumière's autochrome plates is the largest; there are a few reproductions of autochromes, some pinatype transparencies, transparencies by the Sanger-Shepherd process, a good show of three-colour prints prepared with the Rotary Company's tissues and with the Autotype Company's tissues, some pinatype three-colour prints, and a few miscellaneous examples. It is clear that all these methods can be made to give good results, but in every section there is evidence that success cannot be expected without skill and practice.

There are no transparencies that surpass, if any equal, the examples of the Sanger-Shepherd process exhibited by Messrs. Sanger-Shepherd and Co., but we are glad to see some excellent autochromes, such as Nos. 108, 113, and 114 by Mr. J. C. Warburg, and No. 89 by Mr. Maurice Meys, as autochrome plates present the simplest method yet known for getting colour results. Many of the autochromes have an unpleasant coloured granulation obvious to anyone of keen vision when the plate is held at the normal distance from the eye. This is doubtless due to the grouping together into patches of the similarly coloured starch grains, and its absence in some examples may justify the hope that the makers can more thoroughly mix the differently coloured grains now than heretofore.

The application of autochrome plates to photomicrography is well exemplified by Drs. O. Rosenheim and H. R. Hurry. These gentlemen also show photomicrographs of the starch grain itself, and the area of the black filling between the coloured grains is larger than one would have expected, probably larger in the particular plate photographed than in many other plates. Mr. Weiborne Piper's copies of autochromes on autochrome plates are very interesting as showing the result of attempts to multiply these colour photographs by exposure in the camera and also by superposition. It is clearly possible to use an autochrome that has not been reversed in the making as a negative from which to prepare other autochromes. Of the prints on paper, those by Mr. H. J. Comley, the secretary of the society, and by the Rotary Photographic Company are specially good, the latter showing excellent portraits of the German Emperor and Empress and of Prof. Ostwald.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Lord Rayleigh will visit Cambridge on Tuesday, Wednesday, and Thursday, June 16, 17, and 18, in order to be installed as Chancellor. At 4 o'clock on Tuesday, June 16, he will open the new extension of the Cavendish Laboratory. On Wednesday, June 17, the Chancellor will hold a levée of members of the Senate in the Fitzwilliam Museum at 11.30. On the same day there will be a Congregation at 3.15 p.m., at which honorary degrees will be conferred. The Chancellor will visit the colleges on the morning of Thursday, June 18, and will be received at the gate of each college at times which will be notified.

Mr. A. C. Pigou, King's College, has been elected professor of political economy in succession to Mr. Alfred Marshall, who has resigned the chair.

Dr. Hobson has been re-appointed as Stokes lecturer in mathematics, and Dr. Baker as Cayley lecturer in mathematics, each for five years from Michaelmas, 1908.

THE Bradford City Council has resolved to extend the technical college at a cost of 19,000*l.*, including equipment and machinery.

A COURSE of three lectures on "Plankton" will be given by Dr. G. Herbert Fowler at University College on June 10, 15, and 23 at 5 p.m. The lectures are to be addressed to advanced students of the University of London and to others interested in zoology; they will be open to the public without fee or ticket.

MR. R. N. RUDMOSE BROWN has been appointed to the newly instituted lectureship in geography in the University of Sheffield. Mr. Brown accompanied the Scottish Antarctic Expedition in 1902 as naturalist to the expedition. He acted in 1906 as Special Commissioner, under the Indian Government, for the investigation of the pearl oyster fisheries of the Mergui Archipelago.

THE International Congress of Historical Science is to be held in Berlin on August 6-12. The work of the congress will be carried on in general and sectional meetings. Among the eight sections are sections on Oriental history; history of Greece and Rome; history of civilisation and the history of thought, mediæval and modern; sciences subsidiary to history (archives, libraries, chronology, diplomatic, epigraphy, genealogy, historical geography, heraldry, numismatics, palæography, study of seals). Copies of the programme can be obtained from the secretary of the congress, Dr. Caspar, Kaiser-Allee 17, Berlin W. 15.

A COMBINED examination for twenty-three medical entrance scholarships and exhibitions of an aggregate total value of about 1500*l.*, tenable in the faculties of medical sciences of University College, King's College, and in the medical schools of King's College Hospital, St. George's Hospital, Westminster Hospital, and the London School of Medicine for Women, will be held in London by the London Inter-collegiate Scholarships' Board on September 22 and following days. Full particulars and entry forms may be obtained on application to the secretary of the board, Mr. Alfred E. G. Attoe, University College, Gower Street, London, W.C., or to the deans or secretaries of the medical schools concerned.

THE establishment of the proposed university for Bristol and the west of England, to which frequent reference has been made in these columns, will make desirable a scheme of cooperation between the Bristol University College and the Merchant Venturers' Technical College. The Society of Merchant Venturers has had the matter under consideration from time to time, and the proposals of the society, signed by its treasurer, have been printed and circulated. The technical college is carried on in three departments, viz. a secondary school, adult day classes for the study of the higher branches of applied science and technology, and evening classes in technological and commercial subjects for artisans. Only a part of the work is of university standard, and such part the society proposes to submit to the control of the new university, but to continue as before the remaining larger part of the teaching not of university standard. The society has expressed its willingness to undertake the faculty of applied science and engineering in the proposed university, and to hand over this work to academic control, a scheme the society maintains would prevent friction and overlapping. These proposals differ in essential respects from those of the university committee, which appears to have thrown out the suggestion that the society's secondary school should be discontinued in connection with the technical college; that the college buildings in Unity Street should be transferred to the University and used only for applied science and engineering, and that another school of technology under a composite committee should be established. To provide a new site and new secondary school—as was done in the similar case of University College, London—would cost, it is said, some 28,000*l.*, and the money does not seem to be forthcoming. The other suggestions of the university committee fail at present to meet with the approval of the society, but we are hopeful that when the money necessary for the establishment of a new university is available it will prove possible by mutual concessions to develop a plan which, while utilising all work of university standing at present being done, will in no way interfere with other good educational work being accomplished in the city.